EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS

Commonwealth of Massachusetts
Executive Office of Environmental Affairs
Office of Technical Assistance (OTA)

June 2003

Crane & Company, Inc.
Toxics Use Reduction Case Study
Substitution with Carbon Dioxide Eliminates Major Use of Sulfuric Acid

Summary

Crane & Company, Inc. reduced the use of sulfuric acid by approximately 697,000 lbs and sodium hypochlorite by 576,000 lbs between 1999 and 2000, a combined reduction of about 46%. The company achieved these reductions by modifying the process chemistry for the re-pulping of off-specification papers. The sulfuric acid was replaced with an innovative liquid carbon dioxide system and the sodium hypochlorite was reduced by specifying cleaner raw materials, and by controlling the temperature and pH of the process.

Background

Founded in 1801, Crane & Company, Inc. (Crane) is located in Dalton, Massachusetts and is the oldest, continuously run paper manufacturer in North America. Crane is a specialty mill that produces paper requiring highly technical specifications, mostly from cotton and other natural and synthetic fibers. Company products include 100% cotton social stationery, commercial printing papers, reprographic papers, synthetic fiber non-wovens, and currency and security papers. Crane has been making currency paper for the United States government since 1879.

Toxics Use Reduction

To reuse pre-consumer product, which either does not meet requirements or has been reclaimed from finishing operations (referred to as "broke"), the paper must be reprocessed into a slurry form. Since many of the papers manufactured at the company have a high degree of permanent wet strength, the reprocessing requires the use of an alkaline substance and high temperatures. The pH of the slurried broke is then adjusted with sulfuric acid before being added to the paper making stock.

A toxics use reduction project was initiated by the company's Research and Development (R&D) Department to replace the sulfuric acid used in this process with a less toxic chemical. Crane recognized the benefit that a more benign material would eliminate a significant worker safety hazard, while reducing equipment and maintenance costs associated with a strongly corrosive material such as sulfuric acid.

Laboratory-scale work was performed with production paper from the mill to investigate the feasibility of replacing sulfuric acid with carbon dioxide in the pH adjustment step. Extensive manufacturing trials were then conducted on-site using a portable carbon dioxide unit. The preparation for and execution of these trials involved the supplier of carbon dioxide and Crane's R&D, manufacturing, maintenance, and environmental departments. The challenge of using carbon dioxide in this process was the requirement of elevated temperatures for repulping the broke, because as the temperature increases the solubility of

carbon dioxide decreases. Initial results from the lab work, which was conducted at ambient (room temperature) conditions, showed that the plant process, operating at higher temperature was less than 50% efficient. Through process and equipment modifications evolving over numerous trials, it was finally demonstrated that carbon dioxide could replace sulfuric acid with efficiencies approaching current operations and under ambient conditions. Also, this method could be adapted to other uses of strong acids for pH adjustment.

Crane identified toxics use reduction (TUR) as a priority in its operations, and demonstrated this commitment through internal communications to staff and encouraging employees to visit TUR demonstration sites. The success of this project was attributed both to the education of operations personnel about the goal of eliminating a TUR listed chemical, and to the effort and ideas generated by those people in pursuing that goal.

Results

Crane successfully eliminated the use of approximately 697,000 lbs of sulfuric acid and reduced the use of 576,000 lbs of sodium hypochlorite for the re-pulping of off-specification papers.

At the onset, the carbon dioxide project presented unique challenges with no guarantee of economic benefits. Through the course of development and trials, management supported and encouraged the R&D Department to continue refining the process, despite initial setbacks, until the project was implemented successfully.

The use of carbon dioxide allowed for improved process control and stability. The pH is more consistently controlled using liquid carbon dioxide because carbonic acid (carbon dioxide dissolves in an aqueous solution to form carbonic acid) is a weak acid relative to sulfuric. Another benefit is the elimination of storage and handling of sulfuric acid containers at the facility. Since sulfuric acid is more dangerous and corrosive than liquefied carbon dioxide, the potential for serious accidents and wear and tear on process equipment is greatly reduced.

The carbon dioxide proved to be slightly more cost-effective and improved the efficiency by not causing wide swings in pH that could interfere with the wet end chemistry in the paper making process. Overall, the project resulted in a 3% reduction in pulp production costs.

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